that these were made in a still more restricted region, viz., the pine forests of Pennsylvania. It is hardly conceivable that tables based on data from 160 trees of which only 100 were over 100 years old, in one of the most unimportant pineries of the country, can be sufficiently well founded to command confidence.

Whatever of good is accomplished by the book will be in showing what forest study aims to do, and how it can be made in this country, as in Europe, of direct commercial value.—C. R. B.

NOTES FOR STUDENTS.

CZAPEK has examined the acid root secretions[7] and found that the commonest source of the acid reaction is primary potassic phosphate, primary potassic oxalate occurring in only a few cases. No free acids, with the exception of carbonic acid, were found.

MM. BERTRAND AND MALÈVRE, whose work upon pectase, a new diastatic enzyme, has already been noticed in this journal, find that it is very widely distributed among plants; so widely that they feel justified in saying that it may be regarded as universally diffused in green plants.[8] It is especially abundant in the leaves and probably spreads to the other organs. It may be prepared from alfalfa or clover by braying in an iron mortar full-grown plants, whose juices are then expressed. This fluid is saturated with chloroform to prevent alteration by micro-organisms and set aside for 12–24 hours in an open flask protected from light. It then undergoes a special coagulation, which renders it easy to filter. To the clear liquid twice its volume of 90 per cent. alcohol is added, which throws down a white precipitate which is collected and dissolved in a little water. After twelve hours it is filtered and the almost colorless liquid which runs through is received in four to five volumes of alcohol. The pectase separates anew and is collected and dried in a vacuum. In this way a liter of juice yields $5–8^{grm}$ of a white, non-hygroscopic substance, very soluble in water, which produces a vigorous pectic fermentation. A 1 per cent. solution of pectin will be coagulated in forty-eight hours by the addition of $\frac{1}{1000}$ of its weight of the pectase from alfalfa, or $\frac{1}{1800}$ of the pectase from clover.—C. R. B.

MOLISCH describes[9] a new microchemical reaction for chlorophyll, which depends upon a special relation to potassic hydroxide. If a bit of tissue containing chlorophyll, which should not be wet with water, be transferred to a *saturated* watery solution of KOH, the chlorophyll bodies become almost instantly yellow-brown, changing again in 15–30 minutes almost to green. The

[7] Berichte d. deutsch. bot. Gesells. 14:29. 1896.

[8] Jour. de Bot. —: —. 1896.

[9] Ibid. p. 16.

change of the yellow-brown (which the author compares to the color of living diatoms) to green follows immediately upon heating to the boiling point or by the addition of water, and somewhat less quickly upon the addition of alcohol, ether, or glycerin.

Chlorophyll bodies killed by boiling water, by drying, or by any medium which does not destroy the coloring matter, show this reaction likewise. Solid chlorophyll prepared from an alcoholic extract also shows it. Alkali-chlorophyll does not; which confirms the contention of Tschirch, Schunck, and Marchlewski, as against A. Hansen, that dilute alkalies do alter chlorophyll.

Diatoms and brown algæ, after being killed by boiling water, upon which they become green, show the reaction, but in Florideæ and Cyanophyceæ its value is impaired by the accompanying reactions of phycoerythrin and phycocyanin.

No other bodies have been found by Molisch to respond to the chlorophyll test.—C. R. B.

MOLISCH also gives an account[10] of the crystallization of xanthophyll and his method of recognizing this yellow coloring matter which always accompanies chlorophyll. Inasmuch as the two are separable in solution, it seemed possible to devise a mode of removing the chlorophyll and leaving the xanthophyll *in the leaf*. The process is as follows: Fresh green leaves or small pieces of them are brought into 40 per cent. (by volume) alcohol which contains 20 per cent (by weight) of KOH. In this they remain several days protected from light, until all the chlorophyll is extracted. To prevent absorption of CO_2 this should be done in glass preparation jars with close-fitting glass stoppers. The potash solution is then washed out for several hours with distilled water and permanent preparations made by mounting bits of the leaves in pure glycerin. The xanthophyll is found crystallized in almost every previously chlorophyllous cell.

This process has yielded the described result in about 100 genera of seed plants at different times of year. Only rarely does the xanthophyll remain as yellow drops or diffused in the cell sap.

After giving an account of the physical and chemical peculiarities of the crystals Molisch points out the close similarity of the yellow coloring matters, xanthophyll, chrysophyll, etiolin, phycoxanthin, etc., and their relation to carotin. He proposes the use of the word carotin in the broad sense, already given to it by Zimmerman,[11] to designate all the yellow and orange-red crystals of the leaf obtained by the method described. It would therefore designate not a chemical individual but a group of nearly allied substances, just as "sugar" and "albumen" do.—C. R. B.

[10] Berichte d. deutsch. bot. Gesells. 14:18. 1896.

[11] Bot. Mikrotechnik 99.

IN A SECOND CONTRIBUTION on "The influence of light upon the form of Cacti and other plants,"[12] Goebel discusses the dependence of the form of the leaves of *Campanula rotundifolia* upon the intensity of light and introduces some remarks upon the dependence of the heterophylly of a few other plants upon external factors.

The usual form of *Campanula rotundifolia* is well known in the northern states. The early round leaves, from which it takes its specific name, form a radical rosette, but often perish early, so that the name seems very inappropriate when only the linear-lanceolate upper leaves are seen. The erect flowering branches arise in the axils of the lower leaves of the rosette and normally produce elongated leaves. Goebel was able, by diminishing the light, to cause shoots to produce round leaves exclusively until more strongly illuminated, when they formed long leaves. Others in weak light produced shoots in the upper axils bearing round leaves. But the most instructive case was that in which a shoot, after producing normal leaves, gradually returned to the development of round leaves, those at the tip of a 20^{cm} shoot being of typical orbicular-cordate outline. To determine whether the formation of the round[13] leaves could be suppressed by strong illumination from the beginning, or whether the process of development is so ordered that under all conditions round leaves appear first, plants were subjected to artificial illumination, finally with two arc lamps of 2000 c. p. each. But in no case was the formation of round leaves hindered. Goebel argues, therefore, that *Campanula rotundifolia* has not inherited the *Anlage* of two (or if one considers intermediate forms, many) leaf forms whose appearing is determined by the different degrees of intensity of light as a releasing factor, but only the *Anlage* of the round form, which under the normal condition of sufficient light is transformed into the long type, not suddenly but gradually, so that various intermediate forms appear. In the course of the ontogeny of an individual leaf these intermediate forms do not appear because the transforming factor very early directs the development of the leaf *Anlage* into another course. But if this factor be removed the inherited form reappears, as in the cultures in weak light.—C. R. B.

DR. J. WIESNER, who has contributed so much to the general subject of physiology, gathers up[14] in a rapid review the suggestions he has made in regard to the phenomena and terminology of the inequilateral growth of plant members. Having summarized the various forms of heterotrophy of tissues and members—evidently in many cases a complex phenomenon, which is conditioned on the one hand upon innate peculiarities and on the other upon

[12] Flora **82**: 1–13. 1896.

[13] Goebel says, apparently by a slip of the pen, "Langblattform," instead of "Rundblattform."

[14] Berichte der deutschen botanischen Gesellschaft **13**: 481–495. 1896.

external influences — he proposes to cover all cases by the simple special term *trophy*, which he defines as follows : "By *trophies* I understand all one-sided accelerations of growth in tissues or organs which depend upon the position of the organs concerned ; position being taken in its widest sense as indicating the spatial relation of the heterotrophic organ to the horizontal . . . . and to its mother shoot."[15]

As to position with reference to the horizontal, there are to be distinguished epitrophy and hypotrophy ; as to position with reference to the mother axis, exotrophy and endotrophy. The two latter are fixed by heredity. Influences effective by reason of position with reference to the horizontal, such as light, gravitation, and unequal wetting by precipitation, lead to paratonic trophies, which may be more exactly designated as phototrophy, geotrophy and hydrotrophy.

Wiesner then sums up the final results of his researches on anisophylly, which he holds to be evidently the result of combined trophies, in these words:

"1. Anisophylly, *i. e.*, the inequality of the leaves of the shoot in consequence of position (in the above exactly defined sense) serves, as a rule, to make possible to those plants with more abundant foliage a suitable fixed light position of the leaves themselves without the twisting of the internodes.

"2. For attaining this object plants utilize various trophies, either spontaneous (commonly exotrophy), or paratonic (phototrophy, hydrotrophy, probably also geotrophy), or both, which is the common method."—C. R. B.

IGNAZ FAMILLER has a paper in the current number of *Flora* (April) entitled "Biogenetic researches upon reduced or metamorphosed sexual organs." A brief extract of some of the important points will be useful, but the full paper should be read to appreciate the investigations upon which the conclusions are based. Cases in which plant organs have been reduced or transformed to meet changed conditions are by no means rare, and in the floral parts these phenomena are quite extensive. The author disregards all isolated observations of reduction and transformation, because only chance observations are accessible ; and also excludes all diclinous plants, as they would need an entire paper for adequate consideration. His application of sexual terms to stamens and carpels is certainly reprehensible, but using his own phraseology, the main points are as follows:

Male Organs. — Viewed from the standpoint of the typical structure of the normal anther, the rudimentary organ remains permanently in some stage of development through which the normal organ passes. The degree of devel-

[15] "Ich verstehe unter Trophieen alle an Geweben oder Organen vorkommenden einseitigen Wachsthumsförderungen, welche von der Lage des betreffenden Organs abhängen, wobei aber Lage in weiterem Sinne genommen wird, nämlich als die räumliche Beziehung des heterotrophen Organs zum Horizont . . . . und als die räumliche Beziehung des heterotrophen Organs zu seinem Muttersspross."

opment may vary considerably, sometimes the reduced organs being almost imperceptible and sometimes almost normally developed. Goebel remarks "That 'normally' reduced organs occasionally develop is common enough." The ray flowers of Compositæ, the fifth stamen of *Acanthus mollis* and the outer flower of *Viburnum Opulus* show the stamen in the form of a roundish elevation hardly perceptible to the naked eye. In a further step this first development is visible but no archesporium is formed. In many cases the rudiments are raised upon filaments as in *Catalpa*, or the entire organ may have a leaf-like aspect as in staminodia of *Linum*.

Another step shows that a cell-division which would otherwise lead to normal anther development sets in, but the staminodium remains in an interrupted stage. Here great variations are possible. Only the archesporium mother-cell may differentiate. Usually, however, more divisions occur and one can find the development arrested at all stages. In *Boronia* the staminodia in outward form closely resemble stamens. In *Boronia megastigma*, in earlier stages of development, stamens and staminodia show the same cell divisions, but in the staminodia the archesporium is smaller and so changes itself by repeated division that in the mature staminodium the cell divisions bear no resemblance to those of stamens. A nearly normal development is seen when the anthers form regularly but remain smaller than the perfect anthers, as in *Cassia*. When staminodia are to serve as organs of secretion, cell divisions resembling archesporium formation set in, but the epidermal cells frequently take part and so furnish an outlet for the secretion. The case in which staminodia become petaloid with no trace of anther formation must be considered the most extreme transformation.

As to the function of staminodia, two observers disagree. H. Müller[16] and Heinricher[17] regard them as useless organs, while Kerner v. Merilaun doubts whether any plant produces anything which is not of advantage and which is not necessary. Even those organs which people so freely call "rudimentary" are not without meaning for the life of the plant. Our author believes that the transformed stamens play a useful rôle in the economy of the plant. They may serve for attraction, they may be a protection to the young stigma, they may furnish a resting place for the insect visitor, they may secrete honey, they may direct the insect to the honey or prevent the honey from running out.

In flowers with many stamens and staminodia the transition from one to the other is gradual. A reduction of the anther-cells in size and number, a one-sided development of the same, a crowding from the normal position and also changes in the vascular bundle, filament and connective are shown by transitional forms.

[16] Schenk, Handbuch der Bot. 1.

[17] Oesterreich. Bot. Zeitschrift 44:—. 1894. [no. 2.]

Various examples from *Acanthaceæ, Bignoniaceæ, Commelinaceæ, Gesneriaceæ, Labiatæ* and *Scrophulariaceæ* are considered in detail.

Gynæcium.—Reductions in the gynæcium are not uncommon. Sometimes there is only a slight trace of it, or the carpels may appear as little elevations, the ovary may form and show the beginning of a placenta, the ovule may appear but with the embryo-sac-mother-cell and the integument formation checked, or the embryo-sac may form but with the integuments suppressed, or, finally, the ovule may form normally and may seem capable of fertilization, but on account of position or general weakness of development may become stunted.

Several members of the *Caprifoliaceæ, Valerianaceæ* and *Umbelliferæ* are considered in detail. *Quercus* and *Tilia* proved very difficult, and decisive results were not obtained.

Entire Flowers.—The most easily explained case of reduction of the entire flower is that in which the upper flowers of a rich inflorescence fail to develop because the nutritive materials are taken by the earlier, lower flowers.

Flowers may become sterile on account of abnormal enlargement of the floral axis as in the garden form of *Celosia cristata*, or through the enlargement of the floral envelopes as in *Viburnum* and *Hydrangea*. This completes the transformations which are caused by an effort on the part of the flower to serve other than reproductive purposes, like the attractive apparatus of the transformed flowers of *Muscari comosum*, the reduced flowers of *Rhus Cotinus*, whose pedicels serve as wings for the seed, or, finally, the transformation for glands in *Sesamum*.

Arum maculatum, Brassica oleracea, Celosia cristata, Hydrangea serrata, Muscari comosum, Oncidium heteranthum, Rhus Cotinus, Sesamum orientale, and *Viburnum Opulus* were the forms studied.

The author's résumé of his entire work is about as follows:

1. The reduction or transformation of arrested organs is a standstill (stehen bleibe) at different stages of normal development.

2. In arrested male organs the commonest cases are the following: (*a*) A standstill at a primitive stage with a feeble development of a perianth, or (*b*) a part of the cell-divisions appears which in the normal organ leads to the formation of the anther wall, but the usual archesporium does not proceed further or divide.

In female organs, generally, but not always, the embryo-sac is formed but integument formation is reduced. If the reduced ovules develop like the normal in their entire structure, they are at least smaller.

3. In flowers with many stamens and staminodia the transition from one to the other is gradual.

4. If the reduced male organs form pollen, the pollen grains, though fewer in number, are still like those of the entirely normal organ, an observation which agrees with the results of E. Amelung in his work "Ueber mittlere

Zellengrössen," where he says different sized organs of the same sort in a plant individual consist of cells of the same or nearly the same size (*Flora* —: 207. 1893).

5. Filamentous staminodia as they appear, *e.g.*, in species of *Pentstemon* correspond not to the filament alone, but they show in young stages a remnant of anther formation in their cell structure even if this is not outwardly apparent.

6. The transformed male organs, like normally transformed and sterile entire flowers, serve for the enlargement of the attractive apparatus, for mechanical devices for the direction of insects or for secretion.

7. There is a genuine transformation of the organ. Staminodia begin like normal stamens and partly complete the further development, but toward the end they form organs of secretion.

Finally, it must be noted that mechanical causes cannot explain the reduction or transformation of these organs, because often from the first, without an external cause, a different formation is recognizable. It may be necessary to take into consideration an inner power resting in the plasma, so that sometimes, as Eichler remarks, the later development of the flower even at its earliest inception may exercise a noteworthy influence, and sometimes, by the entrance of internal disturbances, changes in the typical, external form may take place without necessitating the question of atavism.—CHAS. CHAMBERLAIN.